Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2018					

ENG471 – Analogue Devices	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

- Exam has five questions.
- Answer all questions of the exam.
- Exam has 90 marks.

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book 1 x Scrap Paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1 (10 marks)

For the differential amplifier shown in Figure 1, determine the value of input differential signal $v_{id} \equiv v_{B1} - v_{B2}$ that causes $i_{E1} = 0.65\ I$. Assume $V_T = 25$ mV.

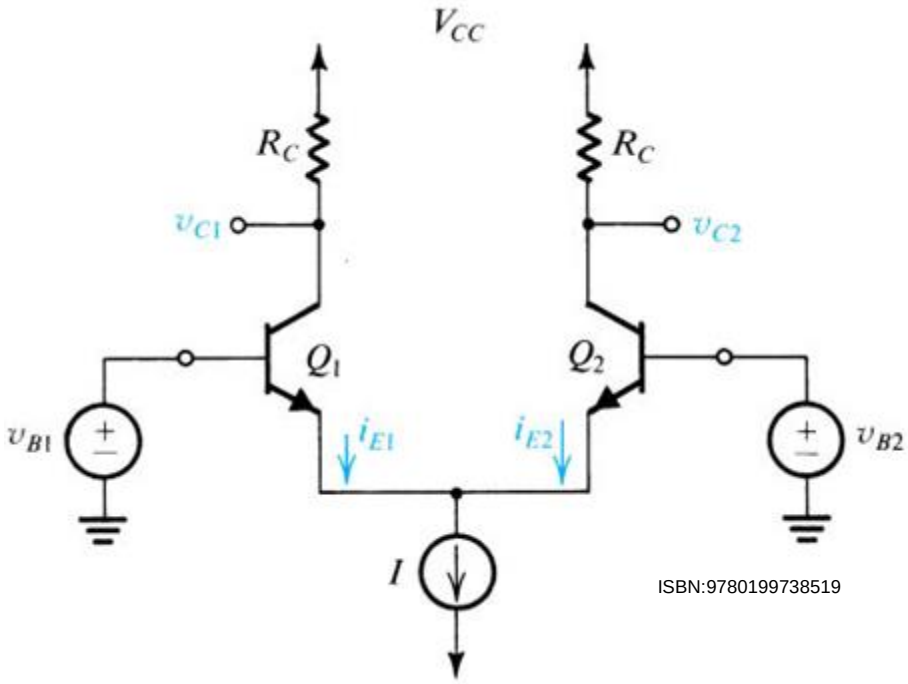

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Figure 1.

Question 2 (20 marks)

For the circuit shown in Figure 2, answer the following questions:

a) Determine current of the transistors (ignore effect of resistance R in your calculation). (3 marks)
b) Determine the overall voltage gain of the amplifier (V_{out}/V_{sig}). (10 marks)
c) Determine the input resistance of the amplifier (R_{in}). (4 marks)
d) Determine the range of output signal, which maintains transistors in saturation region. (3 marks)

Assume $V_{DD}=V_{SS}=2$ V, R=1MΩ, R_{sig}=50 KΩ and R_L=10 KΩ.

For Both transistors:
$k'_n(W/L)= k'_p(W/L)=1$ mA/V^2
$|V_t|=0.5$ V
$|V_A|=20$ V

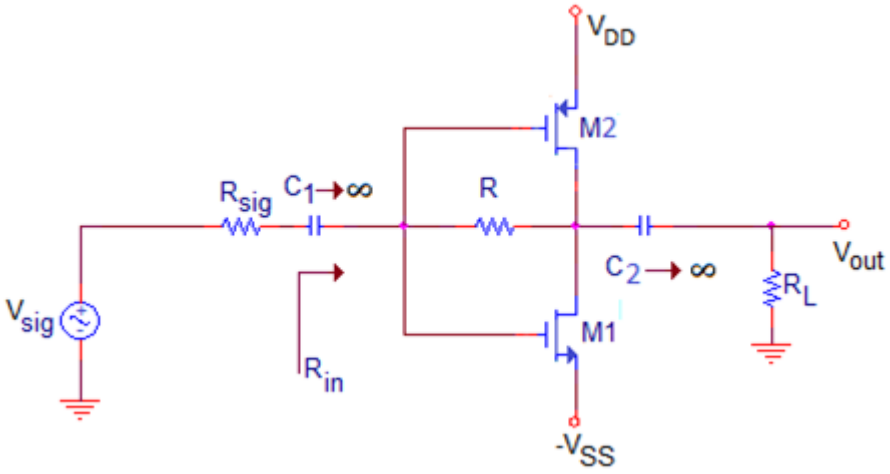

Figure 2.

Question 3 (20 marks)

Apply the open-circuit time constant method and derive an expression for the upper 3dB frequency (f_H) of the circuit shown in Figure 3. In your calculation, consider the Early voltage of transistors.

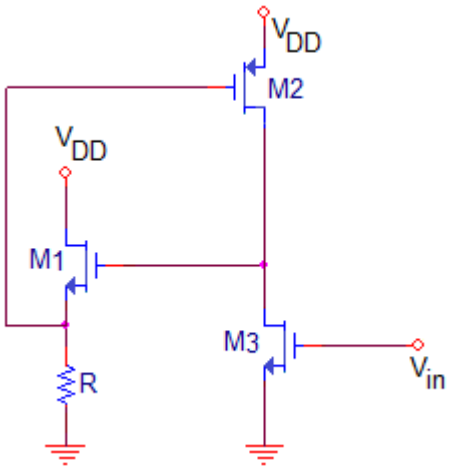

Figure 3.

Question 4 (25 marks)

For the circuit shown in Figure 4, answer the following questions

a) Determine the DC voltage of the circuit at nodes (A) and (B). Assume that the voltage source V_s has the zero DC component. (6 marks)
b) Determine the feedback type of the circuit. (1 mark)
c) Determine feedback parameters of the circuit. (2 marks)
d) Determine open-loop gain of the circuit (A). (9 marks)
e) Determine the closed gain of the circuit (A_f). (1 mark)
f) Determine the voltage gain (V_o/V_s) of the circuit. (2 marks)
g) Determine the input resistance of the circuit. (2 marks)
h) Determine the output resistance of the circuit. (2 marks)

Assume,

β_N=50 (for NPN transistors), β_P=25 (for PNP transistors), $|V_A|$ =50 V (for all transistors)

I_X=0.5 mA

R_F=9 KΩ

R_L=R_{sig}=R_E=1KΩ

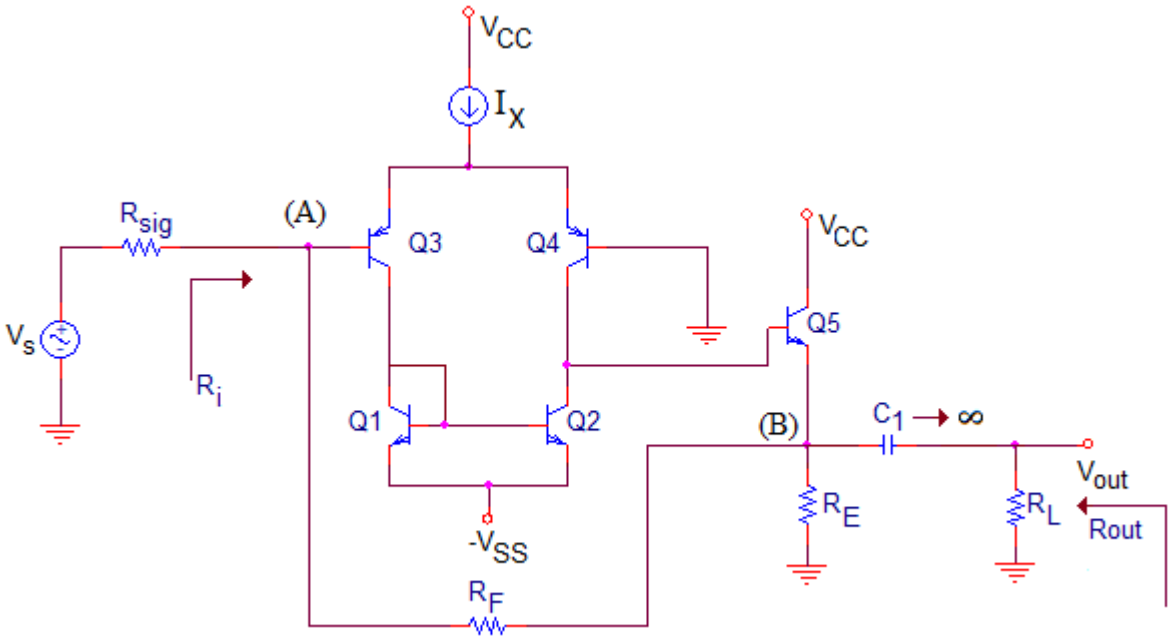

Figure 4.

Question 5 (15 marks)

For the circuit shown in Figure 5, it is required to have the largest maximum swing for the output voltage (V_{out}). What (W/L) should be set for transistor M7 to provide this condition?

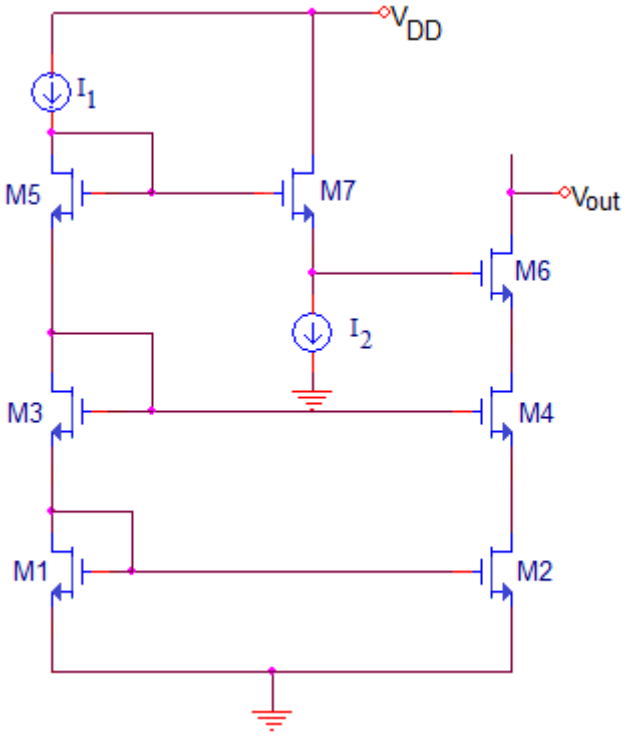

Figure 5.

Assume

$\mu_n C_{ox}$= 0.4 mA/V^2

V_t=0.4 V, λ=0

$(W/L)_1$=50, $(W/L)_2$=500

$(W/L)_3$=20, $(W/L)_4$=500, $(W/L)_5$=25 , $(W/L)_6$=400.

I_1=0.1 mA

I_2=50 µA